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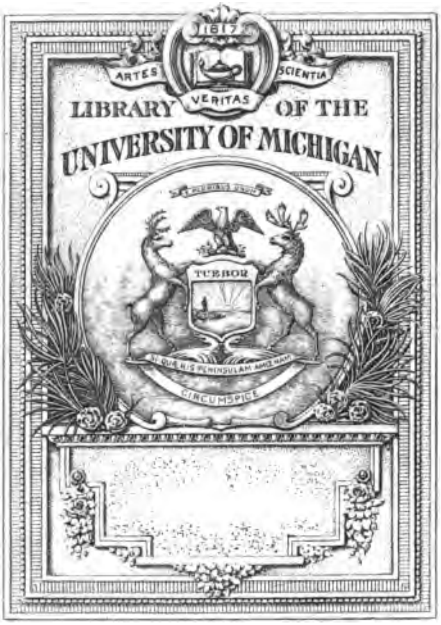
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Osmotic Pressure Measurements of Glucose Solutions at 30°, 40°, 50° and 60°

DISSERTATION

SUBMITTED TO THE BOARD OF UNIVERSITY STUDIES OF
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Osmotic Pressure Measurements of Glucose Solutions at 30°, 40°, 50° and 60°

DESCRIPTION OF APPARATUS.

The Cells[1]

The cells used in the following experiments were made from a mixture of equal parts by weight of the finest portions of a fire clay obtained from Dorsey, Maryland, and of a ball clay obtained from Edgar, Florida. Each of the clays was first washed by elutriation to separate the finer from the coarser portions. The products thus obtained were bolted through a No. 14 and a No. 16 silk bolting-cloth, the latter containing approximately 24,000 holes to the square inch, and then dried. Equal weights of the two clays, thus treated, were ground together (dry) and then bolted (wet), once through a No. 14 and then twice through a No. 16 silk bolting-cloth. The mixture was then partially dried, to the consistency of a putty, and formed into cylinders under a pressure of 20 tons to the square inch, from which cylinders the cells were turned out on the lathe. The cells were then baked at the temperature of Seger cone 7(1270°) and afterwards rebaked at that of cone 8(1290°). The upper half of the baked cells were ground to form upon the lathe and then glazed.

Cells prepared as described above have: first, a great and uniform strength of wall, being able to withstand pressures of certainly more than 30 atmospheres; second, they contain no air blisters which if present would be apt to communicate with each other and with the interior of the porous wall in such ways as to give rise to the formation of a number of subsidary membranes; and third, they have an excessively fine and perfectly uniform texture of wall. If the pores are large the membrane will be formed deeper within the wall, while if they are too small the membrane will be deposited on the inside surface of the cell. Therefore the pores are made so small that the cation is able to pass through them from the exterior to the interior of the wall during the time consumed by the anion in just entering them from the interior, the two ions meeting just within the interior mouths of the pores. If the membrane is deposited in the cell wall and not at the interior surface of the wall, due to the fact that the pores are too large, we find inequalities in the concentration of the solutions which are placed in the cell. Owing to the slowness of diffusion within the cell wall the solution in the neighborhood of the membrane will be permanently less concentrated than the main body of the solution and since the wall is always filled with some liquid it would be impossible to know exactly the final concentration of any solution which is placed in the cell. The above three conditions are necessary characteristics of cells for the successful measurement of osmotic pressure.

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[1] For particulars in regard to these methods the reader is referred to the Monograph by H. N. Morse, Carnegie Publication No. 198, Chapter 1.

Before a membrane can be deposited in a cell, it is necessary to remove completely the air from the pores of the walls. This is effected by means of so-called "electrical endosmose," that is by electrolyzing a dilute solution of a salt in such a manner that the cation passes through the pores of the wall. Lithium sulphate is selected because the cation of that salt carries the largest "atmosphere" of water. The cell is filled with and immersed in the solution to a point above the lower limit of the glaze. Platinum electrodes are used for the electrolysis. When the air has been completely removed from the cell wall, the solution of lithium sulphate is replaced by distilled water and the electrolysis is continued until the water shows a conductivity which is nearly normal for distilled water.

The cell is then ready for the deposition of the membrane and henceforth is allowed to soak in distilled water or in water containing thymol in solution except when the membrane is being deposited or when the cell is actually in use for the measurement of osmotic pressure.

The Membranes.[2]

The membranes, copper ferrocyanide, are deposited in the cell electrolytically with the use of a platinum cathode and a copper anode. The cell, freed from air and with the pores containing water, is filled with a 0.01 normal solution of potassium ferrocyanide and is immersed in a solution of copper sulphate which is 0.1 normal. The platinum cathode is placed within the cell and the copper anode surrounds it. The votage ordinarily employed is 110.

At first the resistance is very high because the cell wall is filled with nearly pure water but it soon falls to a minimum and then increases steadily until it reaches a maximum which it is possible to obtain at that "running." If the electrolysis is continued beyond this point the resistance falls steadily until the circuit is broken. This strange behavior of the membrane appears to have

[2] Ibid. Chapter 4.

some connection with an accumulation of alkali in the cell or perhaps in the membrane itself; therefore during the electrolysis at 30° and 40° the potassium ferrocyanide solutions is renewed every 5 minutes and at 50° and 60° every 2 or 3 minutes. By frequent renewals of the potassium ferrocyanide solution the final decline in resistance may be postponed but not indefinitely, hence it is suspected that the phenomena is possibly due to an accumulation of alkali in the membrane itself.

When the resistance has reached a maximum the electrolysis is discontinued, and the cell is allowed to soak in distilled water or in water containing thymol in solution for at least two days when the membrane-forming process is repeated. On the second and on the several succeeding runnings higher and still higher resistances are secured. The repetition of this membrane-forming process followed each time by prolonged soaking of the cell in pure water is continued until the resistance of the membrane can be forced no higher. When this point is reached the membrane is subjected to a process of "seasoning" under pressure, that is a concentrated solution of cane sugar containing a small amount of potassium ferrocyanide is placed in the cell and the cell stands in a solution of copper sulphate which is isosmotic in reference to the potassium ferrocyanide. The initial mechanical pressure brought upon the contents of the cell when it is closed may be above or below the osmotic pressure of the solution. In either case the mercury meniscus generally comes to rest at a point below which it should stop, showing that the solution has been diluted. After the pressure has become constant, the cell is emptied and allowed to soak in distilled water for one or two days and then subjected to the membrane-forming process. This method of seasoning and membrane-forming is continued until the cell registers the true osmotic pressure of the solution which it contains. The cell is then ready for the measurement of osmotic pressure.

In measuring pressures at the higher temperatures, that is from 50° to 70°, the membrane is first deposited and developed in the cell at a lower temperature, for example 30°, then the temperature raised slowly to 40° and the membrane again developed and so on at intervals of from 5° to 10°, until the temperature is reached where the cells are to be used, when they are again subjected to the seasoning and membrane-forming processes before they are to be used for the measurement of osmotic pressure. The membrane is developed at the temperature at which it is afterwards to be employed for the measurement of pressure and when the cell is not in use it is allowed to soak in water at this temperature. The benficial effect of water upon the membrane is not fully understood, but it is supposed to preserve the colloidal condition of the membrane by extracting from it the alkaline metals.

The activity of a membrane, that is the rate at which the solvent will pass through it, depends upon its area which is the aggregate area of the pores at their mouths. We do not know the relative areas of the membranes but we know that water passes more slowly through a membrane in a hard-burned cell, in which the pores are presumably small, than it does through a membrane of a soft-burned one, in which the pores are presumably large. Also the rate at which water passes through a given membrane decreases with age. It is believed that the activity of the membrane increases with temperature and that the rate of passage of the solvent through a given membrane depends upon the difference between th pressure existing in the cell and the true osmotic pressure of the solution.

In working at the lower temperatures, 30° to 50°, all the solutions contain thymol dissolved in them. Thymol is added to the solutions to kill a nitrogen-consuming fungus, penicillium glaucum, which otherwise destroys the membrane.

Manometers.[3]

The manometers which are used for the measurement of osmotic pressure have an external diameter of about 6 millimeters and an internal one ranging from 0.45 to 0.72 millimeter.

The reasons for using tubes of very small bore are:

1. It is necessary to fill the upper ends of the manometers with short columns of mercury; first, because in closing the instruments, after the introduction of the gas, the calibre of the tube in that region is affected to an unknown extent; second, because it enables one to isolate and protect from contamination, during closing, the nitrogen gas with which the manometer is filled. If the internal diameter is large the mercury is often dislodged from the top of the manometer by the severe tapping to which the manometers are subjected at certain times.

2. The compression of the small volume of gas which they contain involves but little, if any, dilution of the contents of the cell.

3. Relatively smaller volumes of mercury are required by manometers of small than of large bore.

The disadvantages of using manometers of small bore are:

1. It is more difficult to deal satisfactorily with the meniscus in a narrow than in a wide tube.

2. The capillary depression is greater in small than in large tubes and it varies greatly with slight irregularities of bore.

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[3] Ibid. Chapter 2.

3. The movements of mercury in narrow tubes are strongly influenced by the presence of minute quantities of impurities, whether they are dissolved in the metal or are attached to the surface of the glass.

The mercury which is used to fill the manometers and thermostates is purified in the following manner:

1. The commercial material is first filtered through paper to remove the dirt. It is then heated for four hours in a glass retort, a current of air being forced through the boiling metal. When cool it is again filtered to remove the scum of oxides which was formed during the heating.

2. The mercury is distilled in a vacuum.

3. The distilled mercury is washed by the method of Lothar Meyer, as modified by Hillebrandt, using water containing 2 per cent. of nitric acid and 2 per cent. of mercuros nitrate instead of ferric chloride.

4. After treating the mercury as described above it is again distilled in a vacuum, using a different still than the one which was used for the first distillation.

Before calibrating the manometer two fine lines extending completely around the tube are etched upon it. These lines are usually referred to as the "upper" and "lower" scratch since one is near the upper and the other near the lower limit of the calibrated portion of the manometer. All readings on the manometers are always referred to either the upper or the lower scratch. In calibrating the manometer it is placed on a dividing engine in the horizontal position over a ruled mirror; the screw of the dividing engine having previously been carefully compared with the graduated meter scale employed in the measurement of osmotic pressure.

"The calibration is commenced at the lower scratch and consists in setting the thread of mercury exactly end to end and determining its length, until the thread has passed the upper scratch. It is run out of the tube and weighed. Then the whole of the calibrated portion of the tube is filled with mercury, the thread measured and again run out and weighed. From the length and weight of the long thread, the mean diameter of the bore is calculated; and from the observations on the length of the short thread in the different parts of the tube, a mean calibration unit is derived, and a curve of corrections constructed. Finally a mean value for the double meniscus is obtained from the length and weight relations of the long and short threads. If we multiply the weight of the short thread by the number of times its length is contained in that of the long thread, the difference is the weight of the mercury which would be required to fill all the meniscus spaces which were left vacant in setting the short thread end to end along the tube. Converting this difference in weight into volume and dividing by the number of settings less one, we obtain a mean correction for a double meniscus, which is the meniscus correction to be applied in all measurements of pressure."[4]

The above method holds for those manometers which do not have a wide portion between the two scratches. The only difference in calibrating this type of manometer is in determining the capacity of the wide part as a whole and finally in terms of the calibration unit. To determine the capacity of the wide part of the tube, it is filled with mercury and from the weight of this mercury the total capacity of the wide part of the tube is calculated. This work is verified as follows: the space between the two scratches is filled with mercury and the volume of this mercury should be equal to the sum of the previously found capacities of all of the parts of the tube which were filled by it. The same test can also be applied to the whole tube by filling it with mercury from the lower scratch to the upper limit of the calibration.

The capillary depression of the manometers must be carefully determined at different points on the tube as it is used twice in the measurement of osmotic pressure; first, in the determination of the volume of the nitrogen under standard conditions of temperature and pressure; and second, in the correction of a volume under an unknown pressure, which is the quotient of two volumes. The following method is used to determine capillary depression in the calibrated portions of a manometer; the manometer is attached by means of rubber tubing to another glass tube so wide at the top that its capillary depression in that region can be neglected. By raising or lowering this widened glass tube we can determine the capillary depression at points on the manometer which are only a few millimeters apart. Before a reading can be taken the manometer must be tapped for some time to prevent the mercury from "lagging" in the tube. It is necessary to carry out these operations at a constant temperature to avoid changes in the form of the mercury meniscus.

The manometer is afterwards filled with nitrogen, its volume determined under approximately atmospheric pressure and this volume is then reduced to standard conditions of temperature and pressure. After this operation has been completed the manometer is ready to be used for the determination of osmotic pressure.

The fixing of the manometer in the cell must be so firm that there can be no change in the capacity of the cell, since any movement of the manometer under pressure would infallibly result in a dilution of the contents of the cell. The various devices by which this has been accomplished have been described in the monograph previously referred to, Chapter 1.

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[4] Ibid. Page 31.

The Regulation of the Temperature.[5]

The name "thermometer effects" has been given to a large group of phenomena which follows any fluctuation, however small, in the temperature of a bath. The magnitude and the importance of thermometer effects depends upon the following conditions:

1. "The relative volumes of the liquids, solution and mercury, and of the gas in the cell. As the latter is always very small as compared with the former, slight disturbances of temperature must always produce large thermometer effects.
2. The degree of the "lag" in the passage of solvent through the membrane, which, in turn, depends upon the temperature and the area and age of the membrane.
3. The rapidity with which the changes in temperature are accomplished.
4. The lag in the distribution of the solvent through the solution by diffusion which produces temporary conditions of non-homogeneity in respect to concentration."[6]

If the passage of the solvent through the membrane and its subsequent uniform distribution by diffusion were instantaneous we should then have at all times the osmotic pressure of a solution whose concentration varies with the temperature.

The four different elementary conditions under which fluctuation of temperature take place are:

1. "The temperature of the bath, previously constant, rises and becomes again constant at the higher level.
2. After rising, it falls again to the original level.
3. The temperature of the bath, previously constant, falls and remains constant at a lower level.
4. After falling, it rises again to the original level."[7]

The first condition will be discussed in detail to give some idea of the complexity of these thermometer effects.[8] We will call all positive pressure in the cell which is not osmotic, mechanical; and the sum of the two will be called the total pressure; over-pressure being the difference between the total and the osmotic pressure.

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[5] Ibid. Chapter 3.

[6] Ibid. Page 55.

[7] Ibid. Page 51.

[8] In reference to the other conditions see Ibid. Page 52.

First the temperature is constant, the cell contains a solution of known concentration which is exhibiting only its true osmotic pressure. Now the temperature rises and becomes constant at a higher level, there is an increase in the volume of the liquids in the cell and also of the tension of the gas in the manometer. At this point the total pressure is the sum of the osmotic pressure of the solution and a considerable mechanical pressure due to the expansion of the solution in the cell. The nitrogen in the manometer is compressed to a smaller volume and the mercury meniscus rises and finally reaches a maximum height due to the over-pressure. Also due to this over-pressure there is a very slow outward discharge of the solvent through the membrane which increases the concentration of the solution in the cell producing two effects; first, reducing the mechanical pressure; and second, increasing the osmotic pressure. These two effects oppose each other but they are not equal in their opposite influences upon the magnitude of the pressure in the cell; accordingly the meniscus does not remain at the highest point reached by it but falls and remains constant at a point where the mechanical pressure has disappeared and the only pressure in the cell is the osmotic pressure of a solution more concentrated than the original one.

The final postion of the meniscus depends upon the magnitude of the rise in temperature while the maximum height to which it rises depends upon the magnitude and the rate of the rise in temperature; the greater the latter the larger the thermometer effect.

Thermometer effects when converted into pressure depend upon the volume of the nitrogen in the manometer.

By means of these so-called thermometer effects permanent changes in concentration of the solution in the cell may be produced without a leakage of the solute through the membrane. A solution in a cell may become permanently concentrated if the temperature rises and becomes constant or it may become permanently diluted if the temperature falls and becomes constant. The solution in the cell may become concentrated or diluted even when no change in the temperature of the bath occurs. This happens when a cell is filled with a solution whose temperature differs from that of the bath. When such is the case a concentration or a dilution of the solution depends upon the fact that the temperature of the solution is either lower or higher than that of the bath. There is no difference between the two ways of effecting concentration or dilution as both depend upon the change in volume of a solution due to a difference in temperature between that of the bath and that of the solution.

The regulation of constant temperature baths conform to the following principle:[9]

"If all the water or air in a bath is made to pass rapidly (1) over a continuously cooled surface which is capable of reducing the temperature slightly below that which it is desired to maintain, then (2) over a heated surface which is more efficient than the cooled one but which is under the control of a thermostat, and (3) again over the cooled surface, etc., it should be practicable to maintain in the bath any temperature for which the thermostat is set, and the constancy of the temperature should depend only on the sensitiveness of the thermostat and the rate of flow of the water or air."

The baths in which the membranes are deposited and in which the cells and the solutions are maintained at the same temperature at which the osmotic pressure is to be measured are rectangular in form and are made of wood, lined with tinned copper. These baths are filled with water which is kept in circulation by means of a pump, causing the water to flow over a heated surface, which is under the control of a thermostat. These baths can be regulated to a constant temperature to within 0.1°.

For the measurement of osmotic pressure, especially at the higher temperatures, the baths are made of heavy sheet brass and copper and are round or elliptical in form. The air space, that is the part where the cells are kept during a measurement of pressure, is entirely surrounded by water which is made to circulate rapidly over a heated surface which is under the control of a thermostat. These baths can be regulated to a constant temperature to within 0.01°.

The water in both of these types of baths is heated by gas to within 2° or 3° of the temperature which it is desired to maintain and the difference or "temperature margin" is provided for by means of electric stoves regulated by a thermostat.

The Solutions.[10]

All of the solutions whose osmotic pressure was determined were made up on the weight-normal and not the volume-normal basis, that is, a gram molecular weight of glucose or a decimal part of the same was dissolved in 1000 grams of water instead of diluting the solution, which contained a gram molecular weight of glucose or a decimal part of the same to 1000 cubic centimeters.

The volume-normal system of making up solutions is correct for merely analytical purposes but appears not to hold whenever any phenomena is to be studied in which the influence of the solvent upon the solute is involved. "In cases of the latter kind the true concentration of a solution is determined by the numerical ratio of the molecules of the solute to those of the solvent rather than by the number of solute molecules in a given space. An illustration is, in a volume-normal solution of cane sugar at 0° the numerical ratio of solute to solvent molecules is about 1 to 44.1, while in a volume-normal solution of glucose at the same temperature the ratio is about 1 to 49.2. Therefore with respect to the solvent, the cane sugar solution is 11.5 per cent. more concentrated than the solution of glucose. When stated in terms of osmotic pressure the difference is about 3.7 atmospheres, notwithstanding the fact that equal volumes of the two solutions contain the same number of solute molecules."[11]

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[9] Ibid. Page 56.

[10] Ibid. Chapter 5.

Since it was found that a gram molecular weight of a substance dissolved in water and diluted to 1000 cubic centimeters is not the normal standard for osmotic pressure and that a gram molecular weight of a substance dissolved in 1000 grams of water has an osmotic pressure of 20° which is nearly the same as the pressure which a gram molecular weight of hydrogen would exert, at the same temperature, if its volume was reduced to a litre, and "inasmuch as the obvious cause of the pressure in the cell is a dilution of the solution within by solvent acquired from without, the weight-normal appeared to involve less of hypothesis and to be more rational than the volume-normal system"[12] and hence it has been used in all the work on the measurement of osmotic pressure in this laboratory.

[11] Ibid. Page 100.

[12] Ibid. Page 101.

MEASUREMENTS

TABLE I.

0.1 Wt. normal solution. Expt. 1 at 30°. Cell J_8. Resistance, 275,000 ohms. Manometer 5. Calc. gas pressure, 2.472 atms. Time of setting up cell, May 20, 1913. Barometer during final record: max., 1.000; min., 0.988. Total daily pressures:

Final Record.

	Atms.		Atms.
May 23,	3.464	May 28,	3.472
24,	3.464	30,	3.488
25,	3.466	31,	3.446
26,	3.471	June 1,	3.463
27,	3.474	2,	3.441
		3,	3.462
		(11 days)	

Mean total pressure, May 23-June 3..................3.465 atms
Mean barom. pressure, May 23-June 3 ....0.995 atm.
Mean osmotic pressure, May 23-June 3................2.470 atms.

TABLE II.

0.1 Wt. normal solution. Expt. 2 at 30°. Cell H_4. Resistance, 370,000 ohms. Manometer 15. Calc. gas pressure, 2.472 atms. Time of setting up cell, October 25, 1913. Barometer during final record: max., 1.012; min., 0.992. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 5,	3.485	Nov. 11,	3.476
6,	3.484	12,	3.485
7,	3.481	13,	3.482
8,	3.487		
		(7 days)	

Mean total pressure, Nov. 5-13........................3.481 atms.
Mean barom. pressure, Nov. 5-13.......................1.004 atms.
Mean osmotic pressure, Nov. 5-13......................2.477 atms.
Mean osmotic pressure for Expts. 1 and 2 ....2.474 atms.
Ratio of osmotic to gas pressure 1.000

TABLE III.

0.2 Wt. normal solution. Expt. 1 at 30°. Cell U_6. Resistance, 370,000 ohms. Manometer (5). Calc. gas pressure, 4.943 atms. Time of setting up cell, October 20, 1913. Barometer during final record: max., 1.010; min., 1.001. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 3,	5.944	Nov. 6,	5.955
4,	5.949	7,	5.957
5,	5.942		
			(5 days)

Mean total pressure, Nov. 3-7 ....5.949 atms.
Mean barom. pressure, Nov. 3-7 ....1.007 atms.
Mean osmotic pressure, Nov. 3-7 ....4.942 atms.

TABLE IV.

0.2 Wt. normal solution. Expt. 2 at 30°. Cell A_8 Resistance, 200,000 ohms. Manometer 5. Calc. gas pressure, 4.943 atms. Time of setting up cell, October 20, 1913. Barometer during final record: max., 0.999; min., 0.992. Total daily pressures:

Final Record.

	Atms.		Atms.
Oct. 27,	6.019	Oct. 29,	6.023
28,	6.021	30,	6.024
			(4 days)

Rotation of original solution.............................10.6°
Rotation of solution from cell ....10.75°

Following pressures are corrected for the increase in concentration of the solution:

Mean total pressure, Oct. 27-30..........................5.952 atms.
Mean barom. pressure, Oct. 27-30 ....0.995 atm.
Mean osmotic pressure, Oct. 27-30.....................4.957 atms.
Mean osmotic pressure for Expts. 1 and 2.............4.950 atms.
Ratio of osmotic to gas pressure 1.002

TABLE V.

0.3 Wt. normal solution. Expt. 1 at 30°. Cell C_8. Resistance, 300,000 ohms. Manometer 31. Calc. gas pressure, 7.415 atms. Time of setting up cell, May 13, 1913. Barometer during final record: max., 1.007; min., 0.992. Total daily pressures:

Final Record.

Atms.	Atms.
May 17, 8.428	May 22, 8.412
18, 8.397	23, 8.412
19, 8.422	24, 8.397
20, 8.423	25, 8.409
21, 8.422	26, 8.412
	(10 days)

Mean total pressure, May 17-26........................8.413 atms.
Mean barom. pressure, May 17-26 ....0.997 atm.
Mean osmotic pressure, May 17-26....................7.416 atms.

TABLE VI.

0.3 Wt. normal solution. Expt. 2 at 30°. Cell A_8. Resistance, 400,000 ohms. Manometer (5). Calc. gas pressure, 7.415 atms. Time of setting up cell, May 13, 1913. Barometer during final record: max., 1.007; min., 0.992. Total daily pressures:

Final Record.

Atms.	Atms.
May 18, 8.430	May 23, 8.413
19, 8.422	24, 8.405
20, 8.425	25, 8399
21, 8.426	26, 8.397
22, 8.418	27, 8.406
	(10 days)

Mean total pressure, May 18-27 ....8.414 atms.
Mean barom. pressure, May 18-27 ....0.997 atm.
Mean osmotic pressure, May 18-27 ....7.417 atms.
Mean osmotic pressure for Expts. 1 and 2 ....7.417 atms.
Ratio of osmotic to gas pressure 1.000

TABLE VII.

0.4 Wt. normal solution. Expt. 1 at 30°. Cell Ni_1. Resistance, 300,000 ohms. Manometer 22. Calc. gas pressure, 9.886 atms. Time of setting up cell, May 26, 1913. Barometer during final record: max., 1.014; min., 0.995. Total daily pressures:

Final Record.

	Atms.		Atms.
June 1,	10.916	June 6,	10.869
2,	10.880	7,	10.876
3,	10.871	8,	10.835
4,	10.865	9,	10.878
5,	10.867	10,	10.894
			(10 days)

Mean total pressure, June 1-10 ....10.875 atms.
Mean barom. pressure, June 1-10 .... 1.000 atm.
Mean osmotic pressure, June 1-10 .... 9.875 atms.

TABLE VIII.

0.4 Wt. normal solution. Expt. 2 at 30°. Cell A_8. Resistance, 200,000 ohms. Manometer (5). Calc. gas pressure, 9.886 atms. Time of setting up cell, May 30, 1913. Barometer during final record: max., 1.014; min., 0.995. Total daily pressures:

Final Record.

	Atms.		Atms.
June 3,	10.868	June 8,	10.887
4,	10.875	9,	10.889
5,	10.877	10,	10.897
6,	10.887	11,	10.899
7,	10.887	12,	10.897
			(10 days)

Mean total pressure, June 3-12 ....10.886 atms.
Mean barom. pressure, June 3-12 .... 1.001 atms.
Mean osmotic pressure, June 3-12 .... 9.885 atms.

TABLE IX.

0.4 Wt. normal solution. Expt. 3 at 30°. Cell J_8. Resistance, 150,000 ohms. Manometer 5. Calc. gas pressure, 9.886 atms. Time of setting up cell, October 13, 1913. Barometer during final record: max., 1.000; min., 0.993. Total daily pressures:

Final Record.

Atms.	Atms.
Oct. 15, 10.887	Oct. 17, 10.907
16, 10.877	18, 10.897
	(4 days)

Mean total pressure, Oct. 15-18	10.891 atms.
Mean barom. pressure, Oct. 15-18	0.997 atm.
Mean osmotic pressure, Oct. 15-18	9.894 atms.
Mean osmotic pressure for Expts. 1, 2, and 3	9.885 atms.
Ratio of osmotic to gas pressure	1.000

TABLE X.

0.5 Wt. normal solution. Expt. 1 at 30°. Cell A_8. Resistance, 110,000 ohms. Manometer 5. Calc. gas pressure, 12.358 atms. Time of setting up cell, April 18, 1913. Barometer during final record: max., 1.003; min., 0.985. Total daily pressures:

Final Record.

Atms.	Atms.
Apr. 25, 13.381	Apr. 27, 13.361
26, 13.348	28, 13.330
	(4 days)

Mean total pressure, Apr. 25-28	13.355 atms.
Mean barom. pressure, Apr. 25-28,	0.994 atm.
Mean osmotic pressure, Apr. 25-28	12.361 atms.

TABLE XI.

0.5 Wt. normal solution. Expt. 2 at 30°. Cell G_5. Resistance, 100,000 ohms. Manometer 38. Calc. gas pressure, 12.358 atms. Time of setting up cell, April 29, 1913. Barometer during final record: max., 1.007; min., 0.993. Total daily pressures:

Final Record.

	Atms.		Atms.
May 6,	13.354	May 11,	13.360
7,	13.342	12,	13.358
8,	13,352	13,	13.360
9,	13.362	14,	13.351
10,	13.362	15,	13.358
			(10 days)

Mean total pressure, May 6-15 ....13.356 atms.
Mean barom. pressure, May 6-15 .... 1.001 atms.
Mean osmotic pressure, May 6-15 ....12.355 atms.

TABLE XII.

0.5 Wt. normal solution. Expt. 3 at 30°. Cell U_6. Resistance, 200,000 ohms. Manometer 38. Calc. gas pressure, 12.358 atms. Time of setting up cell, May 16, 1913. Barometer during final record: max., 1.007; min., 0.992. Total daily pressures:

Final Record.

	Atms.		Atms.
May 19,	13.344	May 24,	13.339
20,	13.313	25,	13.340
21,	13.338	26,	13.342
22,	13.333	27,	13.345
23,	13.337		
			(9 days)

Mean total pressure, May 19-27 ....13.337 atms.
Mean barom. pressure, May 19-27 .... 0.998 atm.
Mean osmotic pressure, May 19-27 ....12.339 atms.
Mean osmotic pressure for Expts. 1, 2, and 3 ....12.352 atms.
Ratio of osmotic to gas pressure 1.000

TABLE XIII.

0.6 Wt. normal solution. Expt. 1 at 30°. Cell Q_8. Resistance, 65,000 ohms. Manometer 28. Calc. gas pressure, 14.830 atms. Time of setting up cell, October 28, 1913. Barometer during final record: max., 1.014; min., 0.999. Total daily pressures:

Final Record.

	Atms.		Atms.
Oct. 30,	15,800	Nov. 2,	15.861
31,	15.818	3,	15.862
Nov. 1,	15.833	4,	15.861
			(6 days)

Mean total pressure, Oct. 30-Nov. 4..................15.839 atms.
Mean barom. pressure, Oct. 30-Nov. 4 .... 1.008 atms.
Mean osmotic pressure, Oct. 30-Nov. 4................14.831 atms.

TABLE XIV.

0.6 Wt. normal solution. Expt. 2 at 30°. Cell R_8. Resistance, 20,000 ohms. Manometer 1. Calc. gas pressure, 14.830 atms. Time of setting up cell, October 30, 1913. Barometer during final record: max., 1.012; min., 1.001. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 2,	15.792	Nov. 5,	15.858
3,	15.862	6,	15.881
4,	15.862		
			(5 days)

Mean total pressure, Nov. 2-6 ....15.850 atms.
Mean barom. pressure, Nov. 2-6 .... 1.008 atms.
Mean osmotic pressure, Nov. 2-6 ....14.842 atms.
Mean osmotic pressure for Expts. 1 and 2 ....14.837 atms.
Ratio of osmotic to gas pressure 1.000

TABLE XV.

0.7 Wt. normal solution. Expt. 1 at 30°. Cell S_8. Resistance, 34,400 ohms. Manometer 5. Calc. gas pressure, 17.301 atms. Time of setting up cell, November 1, 1913. Barometer during final record: max., 1.010; min., 1.001. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 3,	18.375	Nov. 6,	18.320
4,	18.325	7,	18.320
5,	18.320		
			(5 days)

Mean total pressure, Nov. 3-7	18.332 atms.
Mean barom. pressure, Nov. 3-7	1.006 atms.
Mean osmotic pressure, Nov. 3-7	17.326 atms.

TABLE XVI.

0.7 Wt. normal solution. Expt. 2 at 30°. Cell Q_8. Resistance, 50,000 ohms. Manometer 31. Calc. gas pressure, 17.301 atms. Time of setting up cell, November 6, 1913. Barometer during final record: max., 1.012; min., 0.983. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 10,	18.312	Nov. 13,	18.332
11,	18.327	15,	18.325
12,	18.332		
			(5 days)

Mean total pressure, Nov. 10-15	18.325 atms.
Mean barom. pressure, Nov. 10-15	1.001 atms.
Mean osmotic pressure, Nov. 10-15	17.324 atms.
Mean osmotic pressure for Expts. 1 and 2	17.325 atms.
Ratio of osmotic to gas pressure	1.001

TABLE XVII.

0.8 Wt. normal solution. Expt. 1 at 30°. Cell G_8. Resistance, 200,000 ohms. Manometer 38. Calc. gas pressure, 19.773 atms. Time of setting up cell, November 3, 1913. Barometer during final record: max., 1.012; min., 0.998. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 11,	20.778	Nov. 13,	20.774
12,	20.773	15,	20.777
			(4 days)

Mean total pressure, Nov. 11-15 .. ..20.775 atms.
Mean barom. pressure, Nov. 11-15 .... 1.006 atms.
Mean osmotic pressure, Nov. 11-15 ....19.769 atms.

TABLE XVIII.

0.8 Wt. normal solution. Expt. 2 at 30°. Cell J_8. Resistance, 280,000 ohms. Manometer 28. Calc. gas pressure, 19.773 atms. Time of setting up cell, November 4, 1913. Barometer during final record: max., 1.012; min., 0.998. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 11,	20.772	Nov. 15,	20.781
12,	20.789	17,	20.752
13,	20.789		
			(5 days)

Mean total pressure, Nov. 11-17 ....20.776 atms
Mean barom. pressure, Nov. 11-17 .... 1.005 atms.
Mean osmotic pressure, Nov. 11-17 ....19.771 atms.
Mean osmotic pressure for Expts. 1 and 2 ....19.770 atms.
Ratio of osmotic to gas pressure 1.000

TABLE XIX.

0.9 Wt. normal solution. Expt. 1 at 30°. Cell X_8. Resistance, 35,000 ohms. Manometer 5. Calc. gas pressure, 22.244 atms. Time of setting up cell, November 7, 1913. Barometer during final record: max., 1.010; min., 1.001. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 13,	23.265	Nov. 18,	23.289
15,	23.235	19,	23.280
17,	23.244		

(5 days)

Mean total pressure, Nov. 13-19 ....23.263 atms.
Mean barom. pressure, Nov. 13-19 .... 1.004 atms.
Mean osmotic pressure, Nov. 13-19 ....22.259 atms.

TABLE XX.

0.9 Wt. normal solution. Expt. 2 at 30°. Cell O_8. Resistance, 1,100,000 ohms. Manometer 27. Calc. gas pressure, 22,244 atms. Time of setting up cell, November 11, 1913. Barometer during final record: max., 1.010; min., 1.001 Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 13,	23.321	Nov. 18,	23.308
15,	23.295	19,	23.276
17,	23.321		

(5 days)

Mean total pressure, Nov. 13-19 ....23.304 atms.
Mean barom. pressure, Nov. 13-19 .... 1.004 atms
Mean osmotic pressure, Nov. 13-19 ....22.300 atms

TABLE XXI.

0.9 Wt. normal solution. Expt. 3 at 30°. Cell S_8. Resistance, 1,100,000 ohms. Manometer 24. Calc. gas pressure, 22.244 atms. Time of setting up cell, November 11, 1913. Barometer during final record: max., 1.010; min., 1.001. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 15,	23.252	Nov. 18,	23.335
17,	23.304	19,	23.267
			(4 days)

Mean total pressure, Nov. 15-19 ....23.290 atms.
Mean barom. pressure, Nov. 15-19 .... 1.004 atms.
Mean osmotic pressure, Nov. 15-19 ....22.286 atms.
Mean osmotic pressure for Expts. 1, 2 and 3 ....22.282 atms.
Ratio of osmotic to gas pressure 1.002

TABLE XXII.

1.0 Wt. normal solution. Expt. 1 at 30°. Cell Ni_1. Resistance, 160,000 ohms. Manometer (5). Calc. gas pressure, 24.716 atms. Time of setting up cell, November 8, 1913. Barometer during final record: max., 1.012; min., 0.998. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 11,	25.713	Nov. 15,	25.755
12,	25.713	17,	25.755
13,	25.724		
			(5 days)

Mean total pressure, Nov. 11-17 ....25.732 atms.
Mean barom. pressure, Nov. 11-17 .... 1.005 atms
Mean osmotic pressure, Nov. 11-17 ....24.727 atms.

TABLE XXIII.

1.0 Wt. normal pressure. Expt. 2 at 30°. Cell W_3. Resistance, 25,000 ohms. Manometer 29. Calc. gas pressure, 24.716 atms. Time of setting up cell, November 8, 1913. Barometer during final record: max., 1.010; min., 1.001 Total daily pressures:

Final Record.

Atms.	Atms.
Nov. 15, 25.668	Nov. 18, 25.699
17, 25.692	19, 25.729
	(4 days)

Mean total pressure, Nov. 15-19 ....25.697 atms.
Mean barom. pressure, Nov. 15-19 .... 1.004 atms.
Mean osmotic pressure, Nov. 15-19 ....24.693 atms.

TABLE XXIV.

1.0 Wt. normal solution. Expt. 3 at 30°. Cell R_3. Resistance, 280,000 ohms. Manometer 15. Calc. gas pressure, 24.716 atms. Time of setting up cell, November 14, 1913. Barometer during final record: max., 1.010; min., 0.996. Total daily pressures:

Final Record.

Atms.	Atms.
Nov. 15, 25.717	Nov. 18, 25.808
16, 25.760	19, 25.783
17, 25.762	
	(5 days)

Mean total pressure, Nov. 15-19 ....25.766 atms.
Mean barom. pressure, Nov. 15-19 .... 1.002 atms.
Mean osmotic pressure, Nov. 15-19 ....24.764 atms.
Mean osmotic pressure for Expts. 1, 2 and 3 ....24.728 atms.
Ratio of osmotic to gas pressure 1.000

TABLE XXV.

0.1 Wt. normal solution. Expt. 1 at 40°. Cell X_8. Resistance, 24,000 ohms. Manometer 27. Calc. gas pressure, 2.553 atms. Time of setting up cell, November 25, 1913. Barometer during final record: max., 1.011; min., 0.985. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 7,	3.544	Dec. 10,	3.572
8,	3.568	11,	3.564
9,	3.566		
			(5 days)

Mean total pressure, Dec. 7-11 .... 3.563 atms.
Mean barom. pressure, Dec. 7-11 .... 0.998 atm.
Mean osmotic pressure, Dec. 7-11 .... 2.565 atms.

TABLE XXVI.

0.1 Wt. normal solution. Expt. 2 at 40°. Cell O_8. Resistance, 25,000 ohms. Manometer 4. Calc. gas pressure, 2.553 atms. Time of setting up cell, November 25, 1913. Barometer during final record: max., 1.011; min., 0.985. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 6,	3.563	Dec. 9,	3.533
7,	3.526	10,	3.542
8,	3.530		
			(5 days)

Mean total pressure, Dec. 6-10 .... 3.539 atms
Mean barom. pressure, Dec. 6-10 .... 0.998 atm.
Mean osmotic pressure, Dec. 6-10 .... 2.541 atms.
Mean osmotic pressure for Expts. 1 and 2 .... 2.553 atms.
Ratio of osmotic to gas pressure 1.000

TABLE XXVII.

0.2 Wt. normal solution. Expt. 1 at 40°. Cell Ni_7. Resistance, 110,000 ohms. Manometer 5. Calc. gas pressure, 5.107 atms. Time of setting up cell, November 26, 1913. Barometer during final record: max., 1.014; min., 1.002. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 29,	6.121	Dec. 2,	6.120
30,	6.116	3,	6.119
Dec. 1,	6.116		
			(5 days)

Mean total pressure, Nov. 29-Dec. 3	6.118 atms.
Mean barom. pressure, Nov. 29-Dec. 3	1.009 atms.
Mean osmotic pressure, Nov. 29-Dec. 3	5.109 atms.

TABLE XXVIII.

0.2 Wt. normal solution. Expt. 2 at 40°. Cell Q_8. Resistance, 25,000 ohms. Manometer 15. Calc. gas temperature, 5.107 atms. Time of setting up cell, December 8, 1913. Barometer during final record: max., 1.008; min., 0.994. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 14,	6.132	Dec. 17,	6.099
15,	6.123	18,	6.104
16,	6.109	19,	6.136
			(6 days)

Mean total pressure, Dec. 14-19	6.117 atms.
Mean barom. pressure, Dec. 14-19	1.002 atms.
Mean osmotic pressure, Dec. 14-19	5.115 atms.
Mean osmotic pressure for Expts. 1 and 2.	5.112 atms.
Ratio of osmotic to gas pressure	1.001

TABLE XXIX.

0.3 Wt. normal solution. Expt. 1 at 40°. Cell R_8. Resistance, 20,000 ohms. Manometer (5). Calc gas pressure, 7.660 atms. Time of setting up cell, December 12, 1913. Barometer during final record: max., 1.007; min., 0.994. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 18,	8.690	Dec. 21,	8.654
19,	8.668	22,	8.649
20,	8.665		

(5 days)

Mean total pressure, Dec. 18-22 ....8.665 atms.
Mean barom. pressure, Dec. 18-22 ....1.000 atm.
Mean osmotic pressure, Dec. 18-22 ....7.665 atms.

TABLE XXX.

0.3 Wt. normal solution. Expt. 2 at 40°. Cell A_8. Resistance, 50,000 ohms. Manometer 15. Calc. gas pressure, 7.660 atms. Time of setting up cell, December 19, 1913. Barometer during final record: max., 1.008; min., 0.978. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 23,	8.663	Dec. 26,	8.648
24,	8.653	27,	8.669
25,	8.647	28,	8.666

(6 days)

Mean total pressure, Dec. 23-28 ....8.658 atms.
Mean barom. pressure, Dec. 23-28 ....0.995 atm.
Mean osmotic pressure, Dec. 23-28 ....7.663 atms.
Mean osmotic pressure for Expts. 1 and 2 ....7.664 atms.
Ratio of osmotic to gas pressure 1.000

TABLE XXXI

0.4 Wt. normal solution. Expt. 1 at 40°. Cell P_8. Resistance, 70,000 ohms. Manometer 22. Calc. gas pressure, 10.213 atms. Time of setting up cell, December 13, 1913. Barometer during final record: max., 1.007; min., 0.994. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 18,	11.159	Dec. 21,	11.183
19,	11.178	22,	11.211
20,	11.189		
			(5 days)

Mean total pressure, Dec. 18-22	11.184 atms.
Mean barom. pressure, Dec. 18-22	1.000 atm.
Mean osmotic pressure, Dec. 18-22	10.184 atms.

TABLE XXXII.

0.4 Wt. normal solution. Expt. 2 at 40°. Cell V_8. Resistance, 50,000 ohms. Manometer 1. Calc. gas pressure, 10,213 atms. Time of setting up cell, December 16, 1913. Barometer during final record: max., 1.008; min., 0.978. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 21,	11.269	Dec. 25,	11.192
22,	11.251	26,	11.182
23,	11.252	27,	11.219
24,	11.221	28,	11.201
			(8 days)

Mean total pressure, Dec. 21-28	11.223 atms.
Mean barom. pressure, Dec. 21-28	0.998 atm.
Mean osmotic pressure, Dec. 21-28	10.225 atms.
Mean osmotic pressure for Expts. 1 and 2	10.205 atms.
Ratio of osmotic to gas pressure	0.999

TABLE XXXIII.

0.5 Wt. normal solution. Expt. 1 at 40°. Cell A_5. Resistance, 550,000 ohms. Manometer 27. Calc. gas pressure, 12.767 atms. Time of setting up cell, December 13, 1913. Barometer during final record: max., 1.007; min., 0.994. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 17,	13.822	Dec. 20,	13.746
18,	13.699	21,	13.744
19,	13.734	22,	13.748
			(6 days)

Mean total pressure, Dec. 17-22 ....13.749 atms.
Mean barom. pressure, Dec. 17-22 .... 1.000 atm.
Mean osmotic pressure, Dec. 17-22 ....12.749 atms.

TABLE XXXIV.

0.5 Wt. normal solution. Expt. 2 at 40°. Cell U_3. Resistance, 35,000 ohms. Manometer 28. Calc. gas pressure, 12.767 atms. Time of setting up cell, December 13, 1913. Barometer during final record: max., 1.007; min., 0.994. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 18,	13.750	Dec. 21,	13.766
19,	13.764	22,	13.770
20,	13.768		
			(5 days)

Mean total pressure, Dec. 18-22 ....13.763 atms.
Mean barom. pressure, Dec. 18-22 .... 1.000 atm.
Mean osmotic pressure, Dec. 18-22 ....12.763 atms.
Mean osmotic pressure for Expts. 1 and 2 ....12.756 atms.
Ratio of osmotic to gas pressure 0.999

TABLE XXXV.

0.6 Wt. normal solution. Expt. 1 at 40° Cell Y_8 Resistance, 35,000 ohms. Manometer (5). Calc. gas pressure, 15.320 atms. Time of setting up cell, December 2, 1913. Barometer during final record: max., 1.011; min., 0.985. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 6,	16.324	Dec. 9,	16.314
7,	16.298	10,	16.330
8,	16.309		

(5 days)

Mean total pressure, Dec. 6-10 .... 16.315 atms.
Mean barom. pressure, Dec. 6-10 .... 0.998 atm.
Mean osmotic pressure, Dec. 6-10 .... 15.317 atms.

TABLE XXXVI.

0.6 Wt. normal solution. Expt. 2 at 40°. Cell V_8. Resistance, 25,000 ohms. Manometer 28. Calc. gas pressure, 15.320 atms. Time of setting up cell, December 2, 1913. Barometer during final record: max., 0.999; min., 0.985. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 3,	16.358	Dec. 6,	16.327
4,	16.306	7,	16.329
5,	16.316		

(5 days)

Mean total pressure, Dec. 3-7 .... 16.327 atms.
Mean barom. pressure, Dec. 3-7 .... 0.994 atm.
Mean osmotic pressure, Dec. 3-7 .... 15.333 atms.
Mean osmotic pressure for Expts. 1 and 2 .... 15.325 atms.
Ratio of osmotic to gas pressure 1.000

TABLE XXXVII.

0.7 Wt. normal solution. Expt. 1 at 40°. Cell G_8. Resistance, 140,000 ohms. Manometer 15. Calc. gas pressure, 17.873 atms. Time of setting up cell, November 24, 1913. Barometer during final record: max., 1.011; min., 0.990. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 1,	18.848	Dec. 4,	18.841
2,	18.866	5,	18.859
3,	18.883	6,	18.848
			(6 days)

Mean total pressure, Dec. 1-6 ....18.857 atms
Mean barom. pressure, Dec. 1-6 .... 1.001 atms.
Mean osmotic pressure, Dec. 1-6 ....17.856 atms.

TABLE XXXVIII.

0.7 Wt. normal solution. Expt. 2 at 40°. Cell V_8. Resistance, 65,000 ohms. Manometer 24. Calc. gas pressure, 17.873 atms. Time of setitng up cell, November 24, 1913. Barometer during final record: max., 1.013; min., 1.001. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 25,	18.903	Nov. 28,	18.870
26,	18.890	29,	18.910
27,	18.896		

Mean total pressure, Nov. 25-29 ....18.894 atms.
Mean barom. pressure, Nov. 25-29 .... 1.008 atms.
Mean osmotic pressure, Nov. 25-29 ....17.886 atms.

TABLE XXXIX.

0.7 Wt. normal solution. Expt. 3 at 40°. Cell U_5. Resistance, 100,000 ohms. Manometer 20. Calc. gas pressure, 17,873. Time of setting up cell, November 26, 1913. Barometer during final record: max., 1.007; min., 0.990. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 2,	18.886	Dec. 5,	18.872
3,	18.874	6,	18.856
4,	18.851		

(5 days).

Mean total pressure, Dec. 2-6	18.868 atms.
Mean barom. pressure, Dec. 2-6	0.999 atm.
Mean osmotic pressure, Dec. 2-6	17.869 atms.
Mean osmotic pressure for Expts. 1, 2 and 3	17.871 atms.
Ration of osmotic to gas pressure	1.000

TABLE XL.

0.8 Wt. normal solution. Expt. I at 40°. Cell U_8. Resistance, 50,000 ohms. Manometer 29. Calc. gas pressure, 20.426 atms. Time of setting up cell, December 1, 1913. Barometer during final record: max., 1.007; min., 0.990. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 2,	21.458	Dec. 5,	21.442
3,	21.429	6,	21.417
4,	21.429		

(5 days)

Mean total pressure, Dec. 2-6	21.435 atms
Mean barom. pressure, Dec. 2-6	0.999 atm.
Mean osmotic pressure, Dec. 2-6	20.436 atms.

TABLE XLI.

0.8 Wt. normal solution. Expt. 2 at 40°. Cell T_5. Resistance, 280,000 ohms. Manometer 31. Calc. gas pressure, 20.426 atms. Time of setting up cell, December 5, 1913. Barometer during final record: max., 1.007; min., 1.000. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 10,	21.354	Dec. 13,	21.410
11,	21.375	14,	21.429
12,	21.375		

	(5 days)
Mean total pressure, Dec. 10-14	21.388 atms.
Mean barom. pressure, Dec. 10-14	1.003 atms.
Mean osmotic pressure, Dec. 10-14	28.385 atms.
Mean osmotic pressure for Expts. 1 and 2	20.411 atms.
Ratio of osmotic to gas pressure	0.999

TABLE XLII.

0.9 Wt. normal solution. Expt. 1 at 40°. Cell J_3. Resistance, 100,000 ohms. Manometer 28. Calc. gas pressure, 22.980 atms. Time of setting up cell, November 24, 1913. Barometer during final record: max., 1.014; min., 1.001. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 26,	23.882	Nov. 29,	23.944
27,	23.889	30,	23.985
28,	23.929		

	(5 days)
Rotation of original solution	44.7°
Rotation of solution from cell	44.55°

Following pressures are corrected for dilution of solution:

Mean total pressure, Nov. 26-30	24.003 atms.
Mean barom. pressure, Nov. 26-30	1.010 atms.
Mean osmotic pressure, Nov. 26-30	28.993 atms.

TABLE XLIII.

0.9 Wt. normal solution. Expt. 2 at 40°. Cell R_8. Resistance, 20,000 ohms. Manometer 25. Calc. gas pressure, 22.980 atms. Time of setting up cell, November 28, 1913. Barometer during final record: max., 0.999; min., 0.985. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 3,	24.057	Dec. 6,	24.030
4,	24.056	7,	24.027
5,	24.044		
			(5 days)

Mean total pressure, Dec. 3-7 ....24.043 atms.
Mean barom. pressure, Dec. 3-7 .... 0.994 atm.
Mean osmotic pressure, Dec. 3-7 ....23.049 atms.

TABLE XLIV.

0.9 Wt. normal solution. Expt. 3 at 40°. Cell A_8. Resistance, 275,000 atms. Manometer 38. Calc. gas pressure, 22.980 atms. Time of setting up cell, November 29, 1913. Barometer during final record: max., 0.999; min., 0.985. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 4,	23.950	Dec. 7,	23.966
5,	23.952	8,	23.978
6,	23.961		
			(5 days)

Mean total pressure, Dec. 4-8 ....23.962 atms
Mean barom. pressure, Dec. 4-8 .... 0.993 atm.
Mean osmotic pressure, Dec. 4-8 ....22.969 atms.
Mean osmotic pressure for Expts. 1, 2 and 3 ....23.004 atms.
Ratio of osmotic to gas pressure 1.001

TABLE XLV.

1.0 Wt. normal solution. Expt. 1 at 40°. Cell Q_8. Resistance, 65,000 ohms. Manometer (5). Calc. gas pressure, 25.533 atms. Time of setting up cell, November 21, 1913. Barometer during final record: max., 1.014; min., 1.009. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 28,	26.543	Dec. 1,	26.558
29,	26,.514	2,	26.499
30,	26.558		

(5 days)

Mean total pressure, Nov. 28-Dec. 2 ....26:534 atms.
Mean barom. pressure, Nov. 28-Dec. 2 .... 1.011 atms.
Mean osmotic pressure, Nov. 28-Dec. 2 ....25.523 atms.

TABLE XLVI.

1.0 Wt. normal solution. Expt. 2 at 40°. Cell P_8. Resistance, 44,000 ohms. Manometer 29. Calc. gas pressure, 25.533 atms. Time of setting up cell, November 21, 1913. Barometer during final record: max., 1.014; min., 1.009. Total daily pressures:

Final Record.

	Atms.		Atms.
Nov. 27,	26.482	Nov. 30,	26.545
28,	26.501	Dec. 1,	26.558
29,	26.514		

(5 days)

Mean total pressure, Nov. 27-Dec. 1 ....26.520 atms.
Mean barom. pressure, Nov. 27-Dec. 1 .... 1.012 atms.
Mean osmotic pressure, Nov. 27-Dec. 1................25.508 atms.

TABLE XLVII.

1.0 Wt. normal solution. Expt. 3 at 40°. Cell U_8. Resistance, 24,000 ohms. Manometer 38. Calc. gas pressure, 25.533 atms. Time of setting up cell, November 21, 1913. Barometer during final record: max., 1.013; min., 0.999. Total daily pressures:

Final Record.

Atms.	Atms.
Nov. 24, 26.582	Nov 27, 26.573
25, 26.579	28, 26.576
26, 26.576	
	(5 days)

Mean total pressure, Nov. 24-28	26.577 atms.
Mean barom. pressure, Nov. 24-28	1.007 atms.
Mean osmotic pressure, Nov. 24-28	25.570 atms.
Mean osmotic pressure for Expts. 1, 2 and 3	25.534 atms.
Ratio of osmotic to gas pressure	1.000

TABLE XLVIII.

0.1 Wt. normal solution. Expt. 1 at 50°. Cell Q_8. Resistance, 80,000 ohms. Manometer 15. Calc. gas pressure, 2.635 atms. Time of setting up cell, March 2, 1914. Barometer during final record: max., 1.015; min., 0.998. Total daily pressures:

Final Record.

Atms.	Atms.
Mar. 19, 3.614	Mar. 22, 3.641
20, 3.637	23, 3.674
21, 3.641	
	(5 days)

Mean total pressure, Mar. 19-23	3.641 atms.
Mean barom. pressure, Mar. 19-23	1.006 atms.
Mean osmotic pressure, Mar. 19-23	2.635 atms.
Ratio of osmotic to gas pressure	1.000

TABLE XLIX.

0.2 Wt. normal solution. Expt. 1 at 50°. Cell A_8. Resistance, 100,000 ohms. Manometer 1. Calc. gas pressure, 5.270 atms. Time of setting up cell, February 27, 1914. Barometer during final record: max., 1.003; min., 0.988. Total daily pressures:

Final Record.

	Atms.		Atms.
Mar. 7,	6.281	Mar. 10,	6.285
8,	6.276	11,	6.282
9,	6.268		
			(5 days)

Mean total pressure, Mar. 7-11	6.278 atms.
Mean barom. pressure, Mar. 7-11	0.995 atm.
Mean osmotic pressure, Mar. 7-11	5.283 atms.

TABLE L.

0.2 Wt. normal solution. Expt. 2 at 50°. Cell R_8. Resistance, 16,000 ohms. Manometer 24. Calc gas pressure, 5.270 atms. Time of setting up cell, March 5, 1914. Barometer during final record: max., 1.005; min., 0.991. Total daily pressures:

Final Record.

	Atms.		Atms.
Mar. 8,	6.262	Mar. 11,	6.264
9,	6.270	12,	6.266
10,	6.267		
			(5 days)

Mean total pressure, Mar. 8-12	6.266 atms.
Mean barom. pressure, Mar. 8-12	0.999 atm.
Mean osmotic pressure, Mar. 8-12	5.267 atms.
Mean osmotic pressure, for Expts. 1 and 2	5.275 atms.
Ratio of osmotic to gas pressure	1.001

TABLE LI.

0.3 Wt. normal solution. Expt. 1 at 50°. Cell X_8. Resistance, 30,000 ohms. Manometer 29. Calc. gas pressure, 7.905 atms. Time of setting up cell, February 26, 1914. Barometer during final record: max., 1.005; min., 0.998. Total daily pressures:

Final Record.

	Atms.		Atms.
Mar. 12,	8.895	Mar. 16,	8.907
13,	8.897	17,	8.910
15,	8.900		
			(5 days)

Mean total pressure, Mar. 12-17 ....8.902 atms.
Mean barom. pressure, Mar. 12-17 ....1.001 atms.
Mean osmotic pressure, Mar. 12-17 ....7.901 atms.

TABLE LII.

0.3 Wt. normal solution. Expt. 2 at 50°. Cell P_8. Resistance, 55,000 ohms. Manometer 5. Calc. gas pressure, 7.905 atms. Time of setting up cell, March 5, 1914. Barometer during final record: max., 1.008; min., 0.998. Total daily pressures:

Final Record.

	Atms.		Atms.
Mar. 13,	8.916	Mar. 16,	8.918
14,	8.915	17,	8.924
15,	8.924		
			(5 days)

Mean total pressure, Mar 13-17 ....8.919 atms.
Mean barom. pressure, Mar.13-17 ....1.002 atms.
Mean osmotic pressure, Mar. 13-17 ....7.917 atms.
Mean osmotic pressure for Expts. 1 and 2 ....7.909 atms.
Ratio of osmotic to gas pressure 1.001

TABLE LIII.

0.4 Wt. normal solution. Expt. 1 at 50°. Cell Ni_7. Resistance, 85,000 ohms. Manometer 56. Calc. gas pressure, 10.540 atms. Time of setting up cell, February 24, 1914. Barometer during final record: max., 1.005; min., 0.991. Total daily pressures:

Final Record.

	Atms.		Atms.
Mar 8,	11.545	Mar. 12,	11.564
9,	11.529	13,	11.526
10,	11.524		

(5 days)

Mean total pressure, Mar. 8-13 .... 11.538 atms.
Mean barom. pressure, Mar. 8-13 .... 1.000 atm.
Mean osmotic pressure, Mar. 8-13 .... 10.538 atms.

TABLE LIV.

0.4 Wt. normal solution. Expt. 2 at 50°. Cell Y_8. Resistance, 44,000 ohms. Manometer 39. Calc. gas pressure, 10.540 atms. Time of setting up cell, February 24, 1914. Barometer during final record: max., 1.003; min., 0.972. Total daily pressures:

Final Record.

	Atms.		Atms.
Mar. 1,	11.567	Mar. 7,	11.512
2,	11.542	8,	11.516
3,	11.486	9,	11.514
4,	11.492	10,	11.515
5,	11.502	11,	11.515
6,	11.509		

(11 days)

Mean total pressure, Mar. 1-11 .... 11.515 atms.
Mean barom. pressure, Mar. 1-11 .... 0.991 atm.
Mean osmotic pressure, Mar. 1-11 .... 10.524 atms.
Mean osmotic pressure for Expts. 1 and 2 .... 10.531 atms.
Ratio of osmotic to gas pressure 0.999

TABLE LV.

0.5 Wt. normal solution. Expt. 1 at 50°. Cell V_8. Resistance, 32,000 ohms. Manometer 1. Calc. gas pressure, 13.175 atms. Time of setting up cell, January 23, 1914. Barometer during final record: max., 1.004; min., 0.977. Total daily pressures:

Final Record.

	Atms.		Atms.
Feb. 4,	14.185	Feb. 7,	14.184
5,	14.203	8,	14.254
6,	14.138		
			(5 days)

Mean total pressure, Feb. 4-8 ....14.193 atms.
Mean barom. pressure, Feb. 4-8 .... 0.996 atm.
Mean osmotic pressure, Feb. 4-8 ....13.197 atms.

TABLE LVI.

0.5 Wt. normal solution. Expt. 2 at 50°. Cell P_8. Resistance, 30,000 ohms. Manometer 1. Calc. gas pressure, 13.175 atms. Time of setting up cell, February 18, 1914. Barometer during final record: max., 1.017; min., 1.005. Total daily pressures:

Final Record.

	Atms.		Atms.
Feb. 23,	14.236	Feb. 26,	14.217
24,	14.207	27,	14.204
25,	14.173		
			(5 days)

Mean total pressure, Feb. 23-27 ....14.207 atms.
Mean barom. pressure, Feb. 23-27 .... 1.009 atms.
Mean osmotic pressure, Feb. 23-27 ....13.198 atms.
Mean osmotic pressure for Expts. 1 and 2 ....13.198 atms.
Ratio of osmotic to gas pressure 1.002

TABLE LVII.

0.6 Wt. normal solution. Expt. 1 at 50 . Cell W_8. Resistance, 34,000 ohms. Manometer 31. Calc. gas pressure, 15.810 atms. Time of setting up cell, December 23, 1913. Barometer during final record: max., 1.005; min., 0.985. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 30,	16.762	Jan. 3,	16.786
Jan. 1,	16.832	5,	16.832
2,	16.802		
			(5 days)

Mean total pressure, Dec. 30-Jan. 5 ....16.803 atms.
Mean barom. pressure, Dec. 30-Jan. 5 .... 0.997 atm.
Mean osmotic pressure, Dec. 30-Jan. 5 ....15.806 atms.

TABLE LVIII.

0.6 Wt. normal solution. Expt. 2 at 50°. Cell O_8. Resistance, 24,000 ohms. Manometer 1. Calc. gas pressure, 15.810 atms. Time of setting up cell, January 7, 1914. Barometer during final record: max., 1.007; min., 0.974. Total daily pressures:

Final Record.

	Atms.		Atms.
Jan. 9,	16.820	Jan. 19,	16.795
10,	16.819	20,	16.780
12,	16.826	21,	16.795
13,	16.785	22,	16.788
			(8 days)

Mean total pressure, Jan. 9-22 ....16.801 atms.
Mean barom. pressure, Jan. 9-22 .... 0.991 atm.
Mean osmotic pressure, Jan. 9-22 ....15.810 atms.
Mean osmotic pressure for Expts. 1 and 2 ....15.808 atms.
Ratio of osmotic to gas pressure 1.000

TABLE LIX.

0.7 Wt. normal solution. Expt. 1 at 50°. Cell U_8. Resistance, 36,000 ohms. Manometer 1. Calc. gas pressure, 18.445 atms. Time of setting up cell, February 9, 1914. Barometer during final record: max., 1.004; min., 0.984. Total daily pressures:

Final Record.

	Atms.		Atms.
Feb. 14,	19.478	Feb. 17,	19.464
15,	19.430	18,	19.402
16,	19.471		

	(5 days)
Mean total pressure, Feb. 14-18	19.449 atms.
Mean barom. pressure, Feb. 14-18	0.996 atm.
Mean osmotic pressure, Feb. 14-18	18.453 atms.

TABLE LX.

0.7 Wt. normal solution. Expt. 2 at 50°. Cell R_5. Resistance, 31,000 ohms. Manometer 4. Calc. gas pressure, 18.445 atms. Time of setting up cell, February 19, 1914. Barometer during final record: max., 1.017; min., 0.998. Total daily pressures:

Final Record.

	Atms.		Atms.
Feb. 22,	19.412	Feb. 26,	19.489
24,	19.416	27,	19.461
25,	19.457		

	(5 days)
Mean total pressure, Feb. 22-27	19.447 atms.
Mean barom. pressure, Feb. 22-27	1.008 atms.
Mean osmotic pressure, Feb. 22-27	18.439 atms
Mean osmotic pressure for Expts. 1 and 2	18.446 atms.
Ratio of osmotic to gas pressure	1.000

TABLE LXI.

0.8 Wt. normal solution. Expt. 1 at 50°. Cell Q_8. Resistance, 73,000 ohms. Manometer 38. Calc. gas pressure, 21.080 atms. Time of setting up cell, December 23, 1913. Barometer during final record: max., 1.005; min., 0.985. Total daily pressures:

Final Record.

	Atms.		Atms.
Dec. 30,	22.124	Jan. 3,	22.056
Jan. 1,	22.140	5,	22.004
2,	22.073		

	(5 days)
Mean total pressure, Dec. 30-Jan. 5	22.079 atms.
Mean barom. pressure, Dec. 30-Jan. 5	0.997 atm.
Mean osmotic pressure, Dec. 30-Jan. 5	21.082 atms.

TABLE LXII.

0.8 Wt. normal solution. Expt. 2 at 50°. Cell Q_8. Resistance, 13,000 ohms. Manometer 38. Calc. gas pressure, 21.080 atms. Time of setting up cell, January 13, 1914. Barometer during final record: max., 1.010; min., 0.986. Total daily pressures:

Final Record.

	Atms.		Atms.
Jan. 27,	21.971	Jan. 30,	22.008
28,	22.001	31,	22.038
29,	22.023		

	(5 days)
Mean total pressure, Jan. 27-31	22.008 atms.
Mean barom. pressure, Jan. 27-31	1.001 atms.
Mean osmotic pressure, Jan. 27-31	21.007 atms.
Mean osmotic pressure for Expts. 1 and 2	21.045 atms.
Ratio of osmotic to gas pressure	0.999

TABLE LXIII.

0.9 Wt. normal solution. Expt. 1 at 50°. Cell U_8. Resistance, 41,000 ohms. Manometer 25. Calc. gas pressure 23.715 atms. Time of setting up cell, January 15, 1914. Barometer during final record: max., 1.010; min., 0.986. Total daily pressures:

Final Record.

Atms.	Atms.
Jan. 23, 24.704	Jan. 29, 24.644
27, 24.656	30. 24.572
28, 24.650	31, 24.588
	(6 days)

Mean total pressure, Jan. 23-31 ....24.636 atms.
Mean barom. pressure, Jan. 23-31 .... 1.003 atms.
Mean osmotic pressure, Jan. 23-31 ....23.633 atms.

TABLE LXIV.

0.9 Wt. normal solution. Expt. 2 at 50°. Cell Q_6. Resistance, 40,000 ohms. Manometer 25. Calc. gas pressure, 23.715 atms. Time of setting up cell, February 9, 1914. Barometer during final record: max., 1.018; min., 0.991. Total daily pressures:

Final Record.

Atms.	Atms.
Feb. 13, 24.712	Feb. 18, 24.653
16, 24.653	19, 24.659
17, 24.659	
	(5 days)

Mean total pressure, Feb. 13-19 ....24.667 atms.
Mean barom. pressure, Feb. 13-19 .... 1.002 atms.
Mean osmotic pressure, Feb. 13-19 ....23.665 atms.
Mean osmotic pressure for Expts. 1 and 2 ....23.649 atms.
Ratio of osmotic to gas pressure 0.998

TABLE LXV.

1.0 Wt. normal solution. Expt. 1 at 50°. Cell Y_3. Resistance, 35,000 ohms. Manometer 38. Calc. gas pressure, 26.350 atms. Time of setting up cell, February 3, 1914. Barometer during final record: max., 1.018; min., 1.003. Total daily pressures:

Final Record.

	Atms.		Atms.
Feb. 10,	27.308	Feb. 13,	27.280
11,	27.316	15,	27.269
12,	27.283		
			(5 days)

Mean total pressure, Feb. 10-15	27.291 atms.
Mean barom. pressure, Feb. 10-15	1.010 atms.
Mean osmotic pressure, Feb. 10-15	26.281 atms.

TABLE LXVI.

1.0 Wt. normal solution. Expt. 2 at 50°. Cell G_1. Resistance, 370,000 ohms. Manometer 29. Calc. gas pressure, 26.350 atms. Time of setting up cell, February 4, 1914. Barometer during final record: max., 1.009; min., 0.998. Total daily pressures:

Final Record.

	Atms.		Atms.
Feb. 20,	27.336	Feb. 23,	27.414
21,	27.350	24,	27.373
22,	27.375		
			(5 days)

Mean total pressure, Feb. 20-24	27.369 atms.
Mean barom. pressure, Feb. 20-24	1.003 atms.
Mean osmotic pressure, Feb. 20-24	26.366 atms.
Mean osmotic pressure for Expts. 1 and 2	26.324 atms.
Ratio of osmotic to gas pressure	0.999

TABLE LXVII.

0.1 Wt. normal solution. Expt. 1 at 60°. Cell A_8. Resistance, 50,000 ohms. Manometer 5. Calc. gas pressure, 2.717 atms. Time of setting up cell, March 30, 1914. Barometer during final record: max., 1.004; min., 0.987. Total daily pressures:

Final Record.

Atms.	Atms.
Apr. 16, 3.721	Apr. 19, 3.725
17, 3.706	20, 3.713
18, 3.719	21, 3.708
	(6 days)

Mean total pressure, Apr. 16-21	3.715 atms.
Mean barom. pressure, Apr. 16-21	0.996 atm.
Mean osmotic pressure, Apr. 16-21	2.719 atms.

TABLE LXVIII.

0.1 Wt normal solution. Expt. 2 at 60°. Cell V_8. Resistance, 14,000 ohms. Manometer 1. Calc. gas pressure, 2.717 atms. Time of setting up cell, June 5, 1914. Barometer during final record: max., 0995; min., 0.991. Total daily pressures:

Final Record.

Atms.	Atms.
June 11, 3.725	June 13, 3.710
12, 3.720	14, 3.689
	(4 days)

Mean total pressure, June 11-14	3.711 atms.
Mean barom. pressure, June 11-14	0.994 atm.
Mean osmotic pressure, June 11-14	2.717 atms.
Mean osmotic pressure for Expts. 1 and 2	2.718 atms.
Ratio of osmotic to gas pressure	1.000

TABLE LXIX.

0.2 Wt. normal solution. Expt. 1 at 60°. Cell Ni_7. Resistance, 34,000 ohms. Manometer 4. Calc. gas pressure, 5.433 atms. Time of setting up cell, June 4, 1914. Barometer during final record: max., 0.998; min., 0.991. Total daily pressures:

Final Record.

	Atms.		Atms.
June 10,	6.463	June 13,	6.440
11,	6.445	14,	6.436
12,	6.431		

	(5 days)
Mean total pressure, June 10-14	6.443 atms.
Mean barom. pressure, June 10-14	0.996 atm.
Mean osmotic pressure, June 10-14	5.447 atms.

TABLE LXX.

0.2 Wt. normal solution. Expt. 2 at 60°. Cell X_8. Resistance, 15,000 ohms. Manometer (5). Calc. gas pressure, 5.433 atms. Time of setting up cell, June 4, 1914. Barometer during final record: max., 0.998; min., 0.991. Total daily pressures:

Final Record.

	Atms.		Atms.
June 10,	6.468	June 13,	6.465
11,	6.454	14,	6.458
12,	6.457		

	(5 days)
Mean total pressure, June 10-14	6.460 atms.
Mean barom. pressure, June 10-14	0.996 atm.
Mean osmotic pressure, June 10-14	5.464 atms.
Mean osmotic pressure for Expts. 1 and 2	5.456 atms.
Ratio of osmotic to gas pressure	1.004

TABLE LXXI.

0.3 Wt. normal solution. Expt. 1 at 60°. Cell P_8. Resistance, 35,000 ohms. Manometer 20. Calc. gas pressure, 8.150 atms. Time of setting up cell ,April 3, 1914. Barometer during final record: max., 1.007; min., 0.985. Total daily pressures:

Final Record.

	Atms.		Atms.
Apr. 8,	9.137	Apr. 12,	9.150
10,	9.131	13,	9.149
11,	9.132		

(5days)

Mean total pressure, Apr. 8-13	9.139 atms.
Mean barom. pressure, Apr. 8-13	0.998 atm.
Mean osmotic pressure, Apr. 8-13	8.141 atms.

TABLE LXXII.

0.3 Wt. normal solution. Expt. 2 at 60°. Cell V_8. Resistance, 15,000 ohms. Manometer 1. Calc gas pressure, 8.150 atms. Time of setting up cell, May 26, 1914. Barometer during final record: max., 1.004; min., 0.993. Total daily pressures:

Final Record.

	Atms.		Atms.
June 1,	9.192	June 4,	9.157
2,	9.176	5,	9.173
3,	9.164		

(5 days)

Mean total pressure, June 1-5	9.172 atms.
Mean barom. pressure, June 1-5	0.999 atm.
Mean osmotic pressure, June 1-5	8.173 atms.
Mean osmotic pressure for Expts. 1 and 2	8.157 atms.
Ratio of osmotic to gas pressure	1.001

TABLE LXXIII.

0.4 Wt. normal solution. Expt. 1 at 60°. Cell J_2. Resistance, 16,000 ohms. Manometer 29. Calc. gas pressure, 10.867 atms. Time of setting up cell, April 6, 1914. Barometer during final record: max., 1.006; min., 0.995. Total daily pressures:

Final Record.

	Atms.		Atms.
Apr. 9,	11.844	Apr. 12,	11.855
10,	11.836	13,	11.851
11,	11.856		
			(5 days)

Mean total pressure, Apr. 9-13	11.848 atms.
Mean barom. pressure, Apr. 9-13	1.000 atm.
Mean osmotic pressure, Apr. 9-13	10.848 atms.

TABLE LXXIV.

0.4 Wt. normal solution. Expt. 2 at 60°. Cell V_2. Resistance, 16,000 ohms. Manometer 1. Calc. gas pressure, 10.867 atms. Time of setting up cell, May 5, 1914. Barometer during final record: max., 0.998; min., 0.988. Total daily pressures:

Final Record.

	Atms.		Atms.
May 7,	11.849	May 10,	11.833
8,	11.843	11,	11.844
9,	11.818		
			(5 days)

Mean total pressure, May 7-11	11.837 atms.
Mean barom. pressure, May 7-11	0.993 atm.
Mean osmotic pressure, May 7-11	10.844 atms.
Mean osmotic pressure for Expts. 1 and 2	10.846 atms.
Ratio of osmotic to gas pressure	0.998

TABLE LXXV.

0.5 Wt. normal solution. Expt. 1 at 60°. Cell Q_6. Resistance, 21,000 ohms. Manometer 15. Calc. gas pressure, 13.584 atms. Time of setting up cell, April 8, 1914. Barometer during final record: max., 1.007; min., 0.987. Total daily pressures:

Final Record.

	Atms.		Atms.
Apr. 12,	14.520	Apr. 15,	14.565
13,	14.533	16,	14.577
14,	14.541		
			(5 days)

Mean total pressure, Apr. 12-16 ....14.547 atms.
Mean barom. pressure, Apr. 12-16 .... 0.998 atm.
Mean osmotic pressure, Apr. 12-16 ....13.549 atms.

TABLE LXXVI.

0.5 Wt. normal solution. Expt. 2 at 60°. Cell V_6. Resistance, 14,000 ohms. Manometer 56. Calc. gas pressure, 13.584 atms. Time of setting up cell, April 8, 1914. Barometer during final record: max., 1.007; min., 0.987. Total daily pressures:

Final Record.

	Atms.		Atms.
Apr. 11,	14.536	Apr. 14,	14.568
12,	14.606	15,	14.568
13,	14.574	16,	14.571
			(6 days)

Mean total pressure, Apr. 11-16 ....14.572 atms.
Mean barom. pressure, Apr. 11-16 .... 0.997 atm.
Mean osmotic pressure, Apr. 11-16 ....13.575 atms.
Mean osmotic pressure for Expts. 1 and 2 ....13.562 atms.
Ratio of osmotic to gas pressure 0.998

TABLE LXXVII.

0.6 Wt. normal solution. Expt. 1 at 60°. Cell U_8. Resistance, 23,060 ohms. Manometer 56. Calc. gas pressure, 16.300 atms. Time of setting up cell, April 22, 1914. Barometer during final record: max., 1.005; min., 0.995. Total daily pressures:

Final Record.

	Atms.		Atms.
Apr. 23,	17.386	Apr. 27,	17.260
25,	17.375	28,	17.254
26,	17.383		
			(5 days)

Mean total pressure, Apr. 23-28 .... 17.331 atms.
Mean barom. pressure, Apr. 23-28 .... 1.001 atms.
Mean osmotic pressure, Apr. 23-28 .... 16.330 atms.

TABLE LXXVIII.

0.6 Wt. normal solution. Expts. 2 at 60°. Cell O_8. Resistance, 15,000 ohms. Manometer 56. Calc. gas pressure, 16.300 atms. Time of setting up cell, April 28, 1914. Barometer during final record: max., 0.994; min., 0.984. Total daily pressures:

Final Record.

	Atms.		Atms.
May 5,	17.252	May 8,	17.280
6,	17.263	9,	17.282
7,	17.287		
			(5 days)

Mean total pressure, May 5-9 .... 17.273 atms.
Mean barom. pressure, May 5-9 .... 0.988 atm.
Mean osmotic pressure, May 5-9 .... 16.285 atms.
Mean osmotic pressure for Expts. 1 and 2 .... 16.308 atms.
Ratio of osmotic to gas pressure 1.001

TABLE LXXIX.

0.7 Wt. normal solution. Expt. 1 at 60°. Cell V_8. Resistance, 48,000 ohms. Manometer 56. Calc. gas pressure, 19.017 atms. Time of setting up cell, June 25, 1914. Barometer during final record: max., 1.000; min., 0.993. Total daily pressures:

Final Record.

	Atms.
June 26,	20.009
27,	20.053
28,	20.040
June 29,	20.040
30,	20.025

	(5 days)
Mean total pressure, June 26-30	20.033 atms.
Mean barom. pressure, June 26-30	0.996 atm.
Mean osmotic pressure, June 26-30	19.037 atms.

TABLE LXXX.

0.7 Wt. normal solution. Expt. 2 at 60°. Cell B_6. Resistance, 180,000 ohms. Manometer 6. Calc. gas pressure, 19.017 atms. Time of setting up cell, June 27, 1914. Barometer during final record: max., 1.002; min., 0.995. Total daily pressures:

Final Record.

	Atms.
June 30,	19.978
July 1,	19.964
July 2,	19.998
3,	20.026

	(4 days)
Mean total pressure, June 30-July 3	19.992 atms.
Mean barom. pressure, June 30-July 3	0.999 atm.
Mean osmotic pressure, June 30-July 3	18.993 atms.
Mean osmotic pressure for Expts. 1 and 2	19.015 atms.
Ratio of osmotic to gas pressure	1.000

TABLE LXXXI.

0.8 Wt. normal solution. Expt. 1 at 60°. Cell V_3. Resistance, 50,000 ohms. Manometer 56. Calc. gas pressure, 21.734 atms. Time of setting up cell, July 7, 1914. Barometer during final record: max., 0.994; min., 0.989. Total daily pressures:

Final Record.

Atms.	Atms.
July 13, 22.782	July 16, 22.757
14, 22.803	17, 22.765
15, 22.773	

	(5 days)
Mean total pressure, July 13-17	22.776 atms.
Mean barom. pressure, July 13-17	0.992 atm.
Mean osmotic pressure, July 13-17	21, 784 atms.

TABLE LXXXII.

0.8 Wt. normal solution. Expt. 2 at 60°. Cell O_6. Resistance, 70,000 ohms. Manometer 6. Calc. gas pressure, 21.734 atms. Time of setting up cell, August 3, 1914. Barometer during final record: max,. 1.002; min., 0.999. Total daily pressures:

Final Record.

Atms.	Atms.
Aug. 7, 22.763	Aug. 10, 22.710
8, 22.656	11, 22.742
9, 22.727	

	(5 days)
Mean total pressure, Aug. 7-11	22.720 atms.
Mean barom. pressure, Aug. 7-11	1.000 atm.
Mean osmotic pressure, Aug. 7-11	21.720 atms.
Mean osmotic pressure for Expts. 1 and 2	21.752 atms.
Ratio of osmotic to gas pressure	1.001

TABLE LXXXIII.

0.9 Wt. normal solution. Expt. 1 at 60°. Cell Q_6. Resistance, 100,000 ohms. Manometer 56. Calc. gas pressure, 24.450 atms. Time of setting up cell, June 30, 1914. Barometer during final record: max., 1.001; min., 0.994. Total daily pressures:

Final Record.

	Atms.		Atms.
July 2,	25.401	July 5,	25.332
3,	25.405	6,	25.320
4,	25.393		

(5 days)

Mean total pressure, July 2-6 ....25.370 atms.
Mean barom. pressure, July 2-6 .... 0.998 atm.
Mean osmotic pressure, July 2-6 ....24.372 atms.

TABLE LXXXIV.

0.9 Wt. normal solution. Expt. 2 at 60°. Cell O_6. Resistance, 550,000 ohms. Manometer 56. Calc. gas pressure, 24.450 atms. Time of setting up cell, July 17, 1914. Barometer during final record: max., 1.000; min., 0.993. Total daily pressures:

Final Record.

	Atms.		Atms.
July 20,	25.637	July 23,	25.403
21,	25.515	24,	25.432
22,	25.512		

(5 days)

Mean total pressure, July 20-24 ....25.500 atms.
Mean barom. pressure, July 20-24 .... 0.998 atm.
Mean osmotic pressure, July 20-24 ....24.502 atms.
Mean osmotic pressure for Expts. 1 and 2 ....24.437 atms.
Ratio of osmotic to gas pressure 0.999

TABLE LXXXV.

1.0 Wt. normal solution. Expt. 1 at 60°. Cell H_6. Resistance, 160,000 ohms. Manometer 38. Calc. gas pressure, 27.167 atms. Time of setting up cell, July 17, 1914. Barometer during final record: max., 1.000; min., 0.990. Total daily pressures:

Final Record.

	Atms.		Atms.
July 18,	28.127	July 22,	28.053
20,	28.031	23,	28.060
21,	28.034		

(5 days)

Mean total pressure, July 18-23 ....28.061 atms.
Mean barom pressure, July 18-23 .... 0.997 atm.
Mean osmotic pressure, July 18-23 ....27.064 atms.

TABLE LXXXVI.

1.0 Wt. normal solution. Expt. 2 at 60°. Cell C_6. Resistance, 55,000 ohms. Manometer 38. Calc. gas pressure, 27.167 atms. Time of setting up cell, August 10, 1914. Barometer during final record: max., 1.001; min., 0.995. Total daily pressures:

Final Record.

	Atms.		Atms.
Aug. 14,	28.193	Aug. 17,	28.083
15,	28.138	18,	28.119
16,	28.153		

(5 days)

Mean total pressure, Aug. 14-18 ....28.137 atms.
Mean barom. pressure, Aug. 14-18 .... 0.998 atm.
Mean osmotic pressure, Aug. 14-18 ....27.139 atms.
Mean osmotic pressure for Expts. 1 and 2 ....27.102 atms.
Ratio of osmotic to gas pressure 0.998

TABLE LXXXVII.

Calculated Gas Pressures in Atmospheres.

Temp.	Weight-normal Concentrations.									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
30°	2.472	4.943	7.415	9.886	12.358	14.830	17.301	19.773	22.244	24.716
40°	2.553	5.107	7.660	10.213	12.767	15.320	17.873	20.426	22.980	25.533
50°	2.635	5.270	7.905	10.540	13.175	15.810	18.445	21.080	23.715	26.350
60°	2.717	5.433	8.150	10.867	13.584	16.300	19.017	21.734	24.450	27.167

TABLE LXXXVIII.

Mean Osmotic Pressure in Atmospheres.

Temp.	Weight-normal Concentrations.									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
30°	2.474	4.950	7.417	9.885	12.352	14.837	17.325	19.770	22.282	24.728
40°	2.553	5.112	7.664	10.205	12.763	15.325	17.871	20.411	23.004	25.534
50°	2.635	5.275	7.909	10.531	13.198	15.808	18.446	21.045	23.649	26.324
60°	2.718	5.456	8.157	10.846	13.562	16.308	19.015	21.752	24.437	27.102

TABLE LXXXIX.

Ratio of Osmotic to Gas Pressure.

Temp.	Weight-normal Concentrations.									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
30°	1.000	1.002	1.000	1.000	1.000	1.000	1.001	1.000	1.002	1.000
40°	1.000	1.001	1.000	0.999	0.999	1.000	1.000	0.999	1.001	1.000
50°	1.000	1.001	1.001	0.999	1.002	1.000	1.000	0.999	0.998	0.999
60°	1.000	1.004	1.001	0.998	0.998	1.001	1.000	1.001	0.999	0.998